

Remarks

Applicants have carefully reviewed the Office Action issued December 26, 2007. Claims 1-17 are pending herein. By this Amendment, claims 1, 3, 6, 7, 9-12 and 14 have been amended. Claims 8, 13 and 15-17 are cancelled. Claims 1-7, 9-12 and 14 remain pending.

Independent claims 1 and 3 have been, in part, amended to recite “a chemical compound including hydrogen atoms as impurities” and “hydrogen atoms . . . not more than 3 atomic weight% and more than 0 atomic weight%.” Independent claim 6 has been amended to recite, in part, “an organic chemical compound including a hydrogen atom being included as impurities, water also being included as impurities, the amount of the organic chemical compound including a hydrogen atom being 90 weight ppm or less and the amount of the water being 0.5 weight ppm or less.” Independent claim 12 as amended recites: “A gas for a plasma CVD process, comprising an unsaturated carbon fluoride compound, and hydrogen atoms in the amount of not more than 1×10^{-3} atomic % and more than 0 atomic% as impurities.” As will be further described below, U.S. Patent No. 5,989,998 to Sugahara et al. is silent about any hydrogen impurity: for example, “plasma polymerization . . . containing no hydrogen atom” (col. 13, lines 12-20). Moreover, the fluorinated amorphous carbon film “contains no hydrogen atom” (for example, col. 13, lines 27-30; col. 13, lines 48-52, lines 54-57 and lines 59-65; and columns 15 and 16 for similar “no hydrogen atom.”

On the other hand, according to the SUMMARY OF THE INVENTION, paragraph [0008], Applicants state: regarding the present patent application “In the source gas for the fluoridation carbon film, a small amount of hydrogen is included . . .” And, for example, referring to paragraph [0068], a “chemical compound including a hydrogen atom means an organic compound including a hydrogen atom and an inorganic compound including a hydrogen atom such as water, which exist in the gas for a plasma CVD process.” Specific organic compounds including those recited in dependent claims are described in paragraph [0066] and specific quantities are discussed, for example, in paragraph [0069].

In the Office Action of December 26, 2007, claims 1-5 and 12 are rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 5,989,998 to Sugahara et al. ("Sugahara"); claims 6 and 9-11 are rejected under 35 U.S.C. §102(e) as being anticipated by Hirayama et al. (U.S. 6,884,365), hereinafter, Hirayama. Claims 7-11 (and 13-14) are rejected under 35 U.S.C. §103(a) as being unpatentable over Hirayama as applied to claim 6 above. Claims 15-17 are rejected as being unpatentable over Sugahara as applied to claims 1, 3 and 12 above, respectively.

With the substantial incorporation of claims 8 and 13 and new claims 15-17 into amended claims on which they depend, the rejection of claims 8, 13 and 15-17 is rendered moot and will be discussed in the context of the now pending claims. Prior rejections in view of U.S. Patent No. 6,035,803 to Robles et al. ("Robles") and U.S. Patent No. 5,661,093 to Ravi et al. ("Ravi") have been withdrawn.

In view of the remarks herein, Applicants respectfully request reconsideration and withdrawal of the rejections set forth in the Office Action.

I. Rejection of Claims 1-5 and 12

As noted above, claims 1-5 and 12 are rejected under 35 U.S.C. §102(b) as being anticipated by Sugahara which rejection includes independent claims 1, 3 and 12.

Sugahara is cited in part for teaching an interlayer insulating film that is a fluorinated amorphous carbon film formed by inducing plasma polymerization of a material having, as a main component, hexafluoropropene which is a fluorinated carbon compound having a double bond of carbon atoms in a molecule thereof and containing no hydrogen atom (col. 13, lines 12-20). Sugahara states that because the hexafluoropropene contains no hydrogen atom, the resulting interlayer insulating film is a fluorinated amorphous carbon film containing only carbon and fluorine atoms (col. 13, lines 27-30). The reference further discloses that to evaluate the heat resistance of the interlayer insulating film, the semiconductor substrate formed with the fluorinated amorphous carbon film was held at a temperature of 400°C. in vacuum for 1 hour (col. 13, lines 37-41).

Applicants respectfully submit that Sugahara does not anticipate claims 1-5 and 12.

Applicants' invention relates to the technique of forming a fluoridation carbon film that contains 3 atomic % or less of hydrogen atoms and more than 0 atomic %. Moreover, for example, as per independent claim 1 as amended, "hydrogen atoms are included in the fluoridation carbon film, resulting from a chemical compound including hydrogen atoms as impurities." Sugahara is silent about hydrogen atoms as impurities. Sugahara discusses a reduction in film thickness at a temperature of 400° C of about 5% at col. 13, lines 43-44 and continuously repeats that neither a plasma nor a resulting film contain any hydrogen atom.

On the other hand, such a statement of "no hydrogen atom" is suspect to one of ordinary skill in the art from the achieved reduction in film thickness of about 5%. One of ordinary skill may conclude that hydrogen impurity exists in Sugahara at much greater levels than indicated. Sugahara does not teach or suggest whether the source gas may contain a hydrogen-containing impurity, e.g., water, and what amounts of such impurity may be present in the source gas.

A novel finding of the Applicants is that even if a compound including no hydrogen is used in the source gas, impurity hydrogen atoms as water are necessarily contained in the gas used in practice in the industry, resulting in a large amount of hydrogen content in the formed film.

Applicants submit that those skilled in the art, based on the disclosures in JP-A-144675/1998, JP-A-237783/1997 and JP-A-220668/2002 and further based on source gases used in actual practice in the industry, would understand that the Sugahara source gas may in fact contain hydrogen atoms in the form of water (i.e., as an impurity rather than as an intentional ingredient). However, Suguhara does not recognize this issue or teach how to deal with such issue in making semiconductor devices. In other words, those skilled in the art would not rely on Suguhara to overcome problems associated with the presence of even small amounts of hydrogen impurities in the source gas or fluoridation carbon film. As noted above, a feature of the present invention is Applicants' discovery that if the amount of hydrogen included in the formed film is 3 atomic % or less and more than 0 atomic %, the weight reduction of the formed film can be prevented in the subsequent thermal process. This is not taught or suggested in Sugahara.

To the contrary, the present application, for example, teaches at paragraph [0070]: "Thus, if the amount of the chemical compound including a hydrogen atom in the gas for a plasma CVD process is controlled within the above range (see paragraph [0069] for the range), a dielectric constant of the film may be decreased, reproducibility of the film-formation may be improved, and/or generation of the hydrogen fluoride, which has an adverse effect on the semiconductor tip, may be prevented." See M.P.E.P. Section 707.07(f) for ANSWERING ASSERTED ADVANTAGES.

Moreover, as can be seen from Figure 6 of the present application and its attendant description, the weight reduction of the film which corresponds to reduction in film thickness at a temperature of 400° C is much smaller on the order of 3% or less.

Independent claims 1 and 3 are thus allowable at least for reciting "a chemical compound including hydrogen atoms as impurities" and "hydrogen atoms . . . not more than 3 atomic weight% and more than 0 atomic weight%" and for other features not discussed or suggested by Sugahara. Dependent claim 2 is allowable for at least the reasons that independent claim 1 is allowable. Claims 4 and 5 are allowable for at least the reasons that claims 3 (and 4) on which they depend are allowable. Claim 12 is allowable at least for reciting "gas for a plasma CVD process, comprising an unsaturated carbon fluoride compound, and hydrogen atoms in the amount of not more than 1×10^{-3} atomic % and more than 0 atomic% as impurities." Sugahara does not discuss or suggest these features.

II. Rejection of claims 6-7, 9-12 and 14

Claims 8, 13 and 15-17 have been cancelled, thus rendering their rejections moot. The features of claims 8, 13 and 15-17 have been substantially included in amended claims on which they depended. As indicated above, the remaining claims 6-7, 9-12 and 14 are rejected as unpatentable over Hirayama, including independent claims 6 and 12.

Independent claim 6 is allowable for at least the reasons that claims 1 or 3 are allowable and further for at least reciting: "A gas for a plasma CVD process comprising" . . . "an organic chemical compound including a hydrogen atom being included as impurities, water also being

included as impurities, the amount of the organic chemical compound including a hydrogen atom being 90 weight ppm or less and the amount of the water being 0.5 weight ppm or less.”

Hirayama fails to discuss a gas with “an organic chemical compound” (other than “high-purity” octaluoruclopentene) and water with the recited weights. Also, Hirayama, while discussing moisture (which may be water since the Karl Fischer moisture meter is discussed), describes amounts of “not larger than 20 ppm by weight” (col. 8, lines 45-53) or, in example 1, moisture content of 7 ppm by weight (col. 13, lines 45-47) or example 2, 5 ppm by weight (col. 14, lines 66-67) or example 3, 4 ppm by weight (Col. 15, lines 32-33). Nowhere does Hirayama discuss such a small water amount by weight as the recited .5 weight ppm or less. Consequently, claim 6 as amended patentably distinguishes over the applied Hirayama reference.

Claim 7 is patentable for the reasons that independent claim 6 as amended is patentable and further for stating: “wherein the amount of the organic chemical compound including a hydrogen atom is 10 weight ppm or less.” Such an amount of organic chemical compound is not discussed in Hirayama.

Claim 9 is patentable at least for the reasons that the claims on which it depends are patentable.

Claim 10 is patentable at least for the reasons that the claims on which it depends are patentable and further for reciting a “burned adsorbent.” The Examiner cites to col. 9, lines 14-18 where “an absorbent” is mentioned. This is not a discussion or suggestion of a “burned adsorbent” as recited.

Claim 11 is patentable at least for the reasons that the claims on which they depend are allowable.

Claim 12, as with the Sagahara rejection, is patentable for at least the reason of failing to discuss or suggest “gas for a plasma CVD process, comprising an unsaturated carbon fluoride compound, and hydrogen atoms in the amount of not more than 1×10^{-3} atomic % and more than 0 atomic% as impurities.” Hirayama fails to discuss these features as recited.

Claim 14 is patentable at least for the reasons that independent claim 6 on which it depends is allowable and for reciting “the amount of the water included as impurities is 0.1

weight ppm or less." As indicated above the smallest amount of moisture by weight of Hirayama is 4 ppm by weight.

It is noted that Hirayama cited by the Examiner has been brought to the Examiner's attention as having been cited in a European Search Report as EP 1 186 585 in a fourth information disclosure statement filed February 8, 2008. Applicants have reviewed all cited references and, while they may be relevant to the original claims, do not appear to discuss or suggest the features of the claims as currently amended.

III. Conclusion

In view of the remarks herein, Applicants respectfully request that the rejections set forth in the Office Action of December 26, 2007, be withdrawn and that claims 1-7, 9-12 and 14 be allowed.

If any additional fees under 37 C. F. R. §§ 1.16 or 1.17 are due in connection with this filing, please charge the fees to Deposit Account No. 02-4300, Order No. 033082M300.

Respectfully submitted,
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Enclosure: Petition for Extension of Time